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BUREAU OF MINES
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METHODS AND COSTS OF MINING AND CRUSHING GYPSUM AT THE MINE OF THE VICTOR PLASTER, INC., VICTOR, N. Y.

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E. J. LINTNER

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METHODS AND COSTS OF MINING AND CRUSHING GYPSUM AT THE MINE OF THE VICTOR PLASTER, INC., VICTOR, N. Y.[1]

By E. J. Lintner[2]

INTRODUCTION AND ACKNOWLEDGMENTS

This paper is one of a series being prepared by the United States Bureau of Mines describing gypsum mining and crushing methods and costs at various operations throughout the United States. These papers are designed to disseminate technical information regarding methods used. The cost tabulations represent local operating expenditures only and not total production costs. It is recognized that publication of total production costs may in many instances cause embarrassment to individual operators as well as to the industry as a whole. On the other hand, operating costs are essential to a technical discussion and study of the methods employed. The attention of the reader is called specifically to this differentiation so that there may be no misunderstanding of the scope of the cost tabulation.

This paper deals specifically with the mining and crushing methods employed by Victor Plaster, Inc., Victor, Ontario County, N. Y. The maximum annual production capacity of this company is 180,000 tons of crushed gypsum. The methods and practices employed are typical of those followed in the gypsum mines in western New York State. The shaft is, perhaps, the deepest and the thickness of the gypsum mined is above the average for the section.

The mine and plant are about 2 miles northeast of the village of Victor, near Ganargua Creek and connected by rail with the Lehigh Valley R. R.

The author wishes to thank Charles Spengler, vice president and plant manager, and his organization for the invaluable assistance given in assembling these data.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6967."

2/ Associate mining engineer, U. S. Bureau of Mines.

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BRIEF HISTORY AND EARLY DEVELOPMENT OF DISTRICT

The first discovery of gypsum in New York State, and probably the first on record within the country, is generally credited to William Lindsay of the town of Camillus, Onondaga County, in 1792.3/

Previous to 1892, all the gypsum mined was sold in two forms - crude gypsum and ground gypsum for land plaster or fertilizer. The calcining of gypsum was begun in this year in the vicinity of Oakfield, Genesee County. Although the quantity of calcined gypsum increased rapidly from this date, the total amount of gypsum mined, did not increase materially until 1901, when it exceeded the amount mined in 1900 by 100 percent. During the next few years the industry expanded rapidly in the State, and a much greater quantity was mined. In 1907, New York State ranked first in production among the States, fell behind in 1908, regained the lead the following year, and has retained it since then.

No record was kept of the gypsum mined before 1889. It has been estimated that the output averaged 10,000 tons per year until 1826, when the Erie Canal was opened. This new means of transportation enabled the growing industry to reach into more and distant markets. Production induced by this increase of shipping facilities, is said to have averaged 35,000 tons per year until 1889. Total production from 1810 to 1889 has been estimated to have amounted to 2,400,000 tons.4/

The amount of gypsum mined from 1890 to 1935 in New York State, as compared with that mined in the United States, together with the amount calcined, as disclosed by Mineral Resources of the United States and the Minerals Yearbook of the Bureau of Mines, are as follows:

Year	New York State		United States,
	Mined, short tons	Calcined, short tons	mined short tons
1890	32,903		182,995
1895	33,587	3,480	265,503
1900	58,890	27,979	594,462
1905	191,860	130,268	1,043,202
1910	467,339	248,362	2,379,057
1915	540,914	293,870	2,441,611
1920	780,295	387,356	3,129,142
1925	1,730,254	1,193,520	5,678,302
1930	912,070	573,602	3,471,393
1934	391,408	237,438	1,536,170

3/ Newland, D. H., The Gypsum Resources and Gypsum Industry of New York: New York State Museum Bull. 283, November 1929, p. 7.

4/ Stone, R. W., Gypsum Deposits of the United States: U. S. Geol. Survey Bull. 697, 1920, p. 188.

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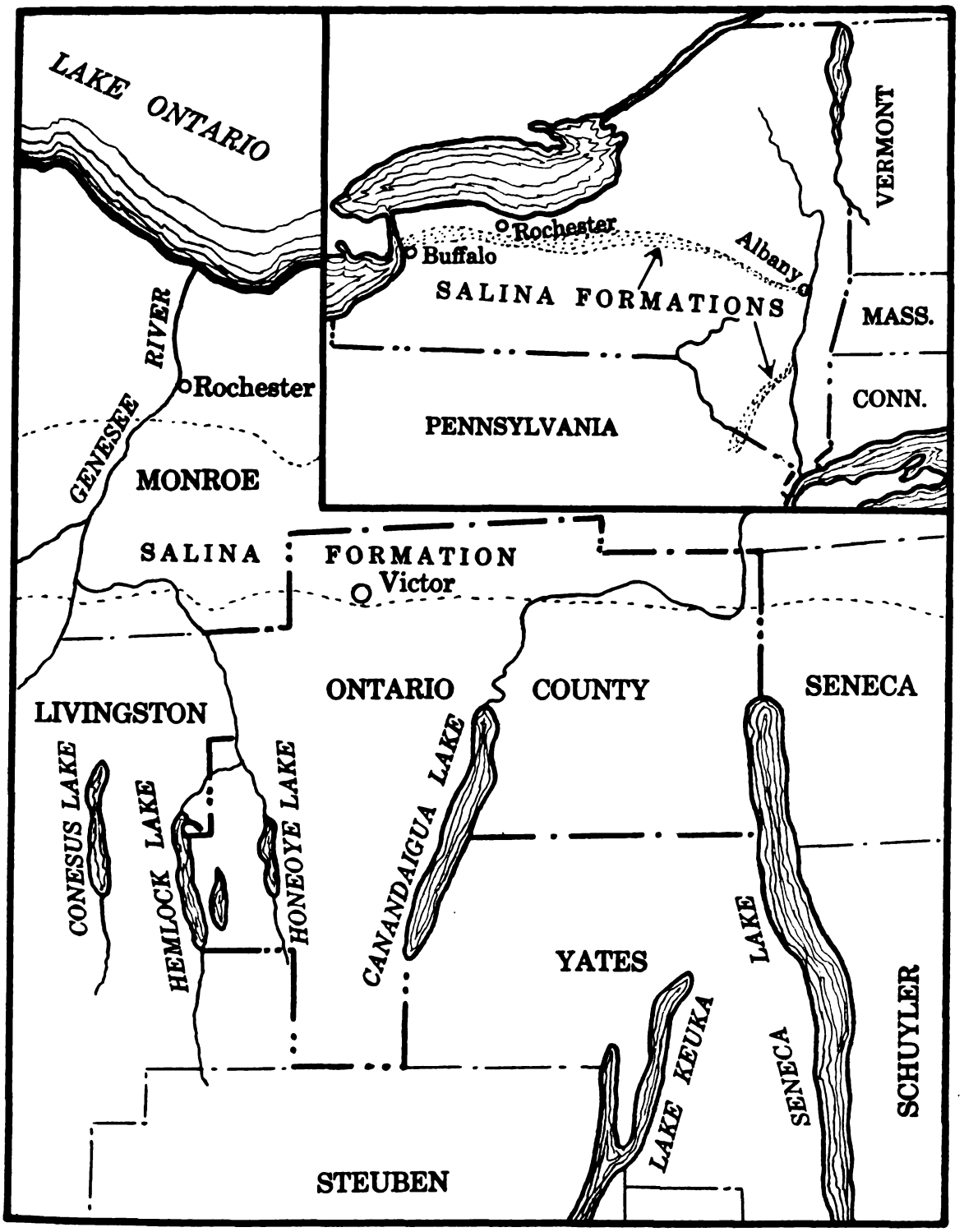

Figure 1.—Salina formation, New York State and Ontario County.

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The rapid increase in production of New York gypsum was halted with the erection of large calcining plants along the Atlantic seaboard, all of them treating gypsum imported from Nova Scotia.

Gypsum had been quarried for some time in Ontario County. Several quarries and a land plaster mill were formerly in the vicinity of Victor. These, however, ceased operation around 1900. In 1907 C. M. Tuttle organized the Victor Gypsum Co. He optioned and leased 365 acres of land near Victor and drilled a series of test holes. Nothing more was done until 1921, when C. A. Huber acquired the same land and organized the Victor Plaster, Inc. Five years later sinking a vertical shaft to the lower bed of gypsum was begun. It was not until 1929, however, that the first gypsum was shipped by this company.

GEOLOGY

In New York State gypsum deposits are found in the Salina formation of the Silurian system. This formation occupies two separate areas within the State (fig. 1). The smaller of these two areas is in the southeastern corner of the State, while the largest and most important one, commercially, extends due west from Albany County, through central and western New York, to the Niagara River, and thence into the Province of Ontario. The strata in Albany County are rather thin, consisting of a few feet of shale. Proceeding westward, the strata increase in thickness as well as lateral extent until, at a point above Lake Cayuga, they attain a maximum width of 20 miles. From there to the Niagara River the width shrinks to from 7 to 10 miles.

"Gypsum is found in variable quantity throughout this part of the belt [Lake Cayuga to the Niagara River]. There is no continuous seam of it nor do the workable deposits make up more than a small proportion of the total area; it is distributed in the form of veins, disseminated crystals, lenses, and broad layers or beds through a vertical range of from 50 to 200 feet or more, and it is only here and there that the deposits have the necessary purity and size to justify mining. Some of the more substantial beds spread over several square miles. Ordinarily, there are two or three seams, separated by barren intervals or by a low-grade gypsum, the individual bodies being too small and thin to be workable. There may be quite as much gypsum, in the aggregate, in a section that contains no sizable single beds as in the productive areas, but it is scattered and admixed with limestone and shale."5/

The gypsum deposits of New York that occur in the Salina formation were deposited by evaporation of surface waters. According to Newland,6/ the evidence that supports this explanation may be summarized under three heads:

1. Form and structure of the deposits.
2. Associations of the calcium sulphate.
3. Biologic conditions in the Salina time.

5/ Newland, D. H., The Gypsum Resources and Gypsum Industry of New York: New York State Museum Bull. 283, November 1929, pp. 35-36.
6/ Same as footnote 5/, p. 62.

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1. The gypsum beds exhibit the same degree of continuity as the enclosing strata, indicating accumulation corresponding with that of the shale, limestone, and salt of the Salina formation. The gypsum beds usually are interbedded in the limestone, sharp planes of separation existing between the two.

2. The close association of the gypsum with limestone, shale, and salt is the normal sequence of deposits formed by evaporation of sea water.

3. Variations in the beds of the Salina formation are accompanied by pronounced fluctuations in the amount of fossil remains. The beds above and below the gypsum exhibit varied fauna. The Camillus beds contain no evidence of marine life of any kind. The salinity of the waters forming these beds was, no doubt, unfavorable to plant and animal life.

The topography of the county is both rolling and flat. The lands in the vicinity of Victor are quite rolling, and they are drained by Canargua Creek, which flows in a northerly and easterly direction and empties into the Canadaigua Lake outlet (fig.1).

The Salina strata in the second or largest area are nearly flat, having a slight but consistent dip towards the south. In the central and western parts of this area the dip varies from 40 to 50 feet per mile. In the eastern section the dip is somewhat higher. The main part of this large area consists of a broad, shallow syncline whose axis runs north and south.

The Salina formation is composed of five members. These are, in descending order, the Bertie limestone, the Camillus beds, the Syracuse salt members, the Vernon shale, and the Pittsford shale. The workable gypsum beds are found at various levels in the Camillus member. The Camillus member consists of a considerable thickness of soft shale containing intercalated layers of magnesian limestone. The thickness of the gypsum beds and shale in the central part of the State averages 300 feet.

PHYSICAL CHARACTERISTICS OF GYPSUM AND ENCLOSING ROCKS

The gypsum is found in regularly stratified beds ranging in thickness from a few inches to 6 feet or more. The strata are not continuous but have the shape of elongated lenses, which succeed each other along the strike and dip. This accounts for the fact that the deposits being worked are separated into several well-defined areas, the adjacent areas being barren of minable gypsum. The main body of gypsum is found usually at varying levels in the Camillus. In the western part of this area the gypsum bed mined lies from 75 to 125 feet below the Bertie limestone.

The Salina formation in Ontario County has the usual east-west strike and a southerly dip of about 40 feet per mile. The width of the outcrop of the Camillus strata entering the county ranges from 5 to 6 miles. The belt narrows to the west to between 2 and 3 miles in Victor township near the Monroe County line. There are few exposures in this area, as the beds generally are covered by glacial drift.

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The Camillus strata in Ontario County consist of thin beds of dolomitic limestone and lime shale, both gray in color. These beds contain many veins of selenite and satin spar. This secondary gypsum was deposited, no doubt, from circulating ground waters coming from the deeper gypsum beds.

The main gypsum deposits in the county are found at two distinct horizons. The first is directly below the Bertie limestone and corresponds to the position of the gypsum deposits in the eastern section of the Salina belt. The second deposit lies about 120 feet beneath the first. This second bed is the one being worked by the Victor Plaster, Inc.

METHODS OF PROSPECTING AND EXPLORATION

When the property was prospected originally by C. M. Tuttle, a series of test holes was drilled with a 4-inch-diameter shot drill. Considerable difficulty was experienced in drilling these holes, so that only six actually reach the second or lower bed of gypsum. Some of these holes were placed along the east property lines, others in the center of the tract. A log of one of the holes in the center of the tract is as follows:

	Ft.	In.
Sandy loam	6	00
Soft shale	7	00
Hard shale	3	00
Soft shale	5	00
Hard shale	1	00
Gypsum mixed with shale	4	00
Limestone and gypsum	3	6
Limestone	12	8
Gypsum (low grade)	22	00
Limestone	8	4
Limestone mixed with gypsum	20	5
Gypsum	6	00
Mixed gypsum	4	2
Dolomitic limestone	6	00
Gypsum ashes	0	10
Gypsum (high grade)	6	00

METHODS OF SAMPLING AND ESTIMATING TONNAGE AND VALUES

Due to the fact that only six test holes, located at scattered points on the 365 acres, actually reached the lower gypsum bed, it was difficult to estimate accurately the available gypsum present.

The body of the gypsum deposit so far revealed in the mine is very uniform in character. Little anhydrite is present, and the small amount of dolomite that falls from the roof is picked out carefully by the loaders. As the quality of the crushed gypsum sold to the cement industry depends largely upon the sulphur trioxide content, it is essential that this dolomite be

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eliminated. To maintain a close check upon the quality of the mined gypsum, samples for chemical analysis are taken at regular intervals after it has passed the crusher. A chemical analysis of the crushed gypsum rock is as follows:

	Percent
Silica (SiO_2).....	1.58
Iron and aluminum oxides (Fe_2O_3) (Al_2O_3)	.28
Calcium oxide (CaO).....	32.04
Magnesium oxide (MgO).....	4.44
Sulphur trioxide (SO_3).....	36.85

METHODS OF DEVELOPMENT AND MINING

The bed of gypsum mined at Victor lies 110 feet beneath the surface. It is uniform throughout, being massive, hard, fine-grained, and brownish-gray and averaging 6 feet in thickness. It is reached through a four-compartment vertical shaft.

The gypsum bed lies practically horizontal, and a triple-entry room-and-pillar system of mining is employed. Rooms and entries are driven 26 feet wide on 41-foot centers. Crosscuts of the same width are made on 46-foot centers. Figure 2 is a plan of the mine workings.

The roof and floor are very uneven. The roof presents a pitted surface clearly exhibiting the effect of wave action in a shallow body of standing water. In places, a seam of dolomite varying in thickness from 4 to 10 inches falls from or is pulled from the roof. This stone is gobbed along the rib and constitutes the only waste material handled in the mining operation.

No pillars are being drawn at present. It is planned to recover them on the retreat after the property limits have been reached.

Fifteen men are employed underground and they produce an average of 150 tons of gypsum during an 8-hour day. This is at the equivalent rate of 1.25 tons per man-hour.

MINING METHODS

Drilling

Electric rotary drills are used to drill the gypsum. These machines are simple and rugged in construction and weigh about 125 pounds. They are powered by 3-horsepower motors having a carbon-steel pinion mounted on the armature shaft meshing with an internal, machine-cut, bronze gear, 12 inches in diameter, through the center of which passes a hollow feed bar. The armature is housed in a two-piece, cast-steel body with pole pieces and hollow-shaft bearings cast integral. The hollow feed bar is 2 inches in diameter,

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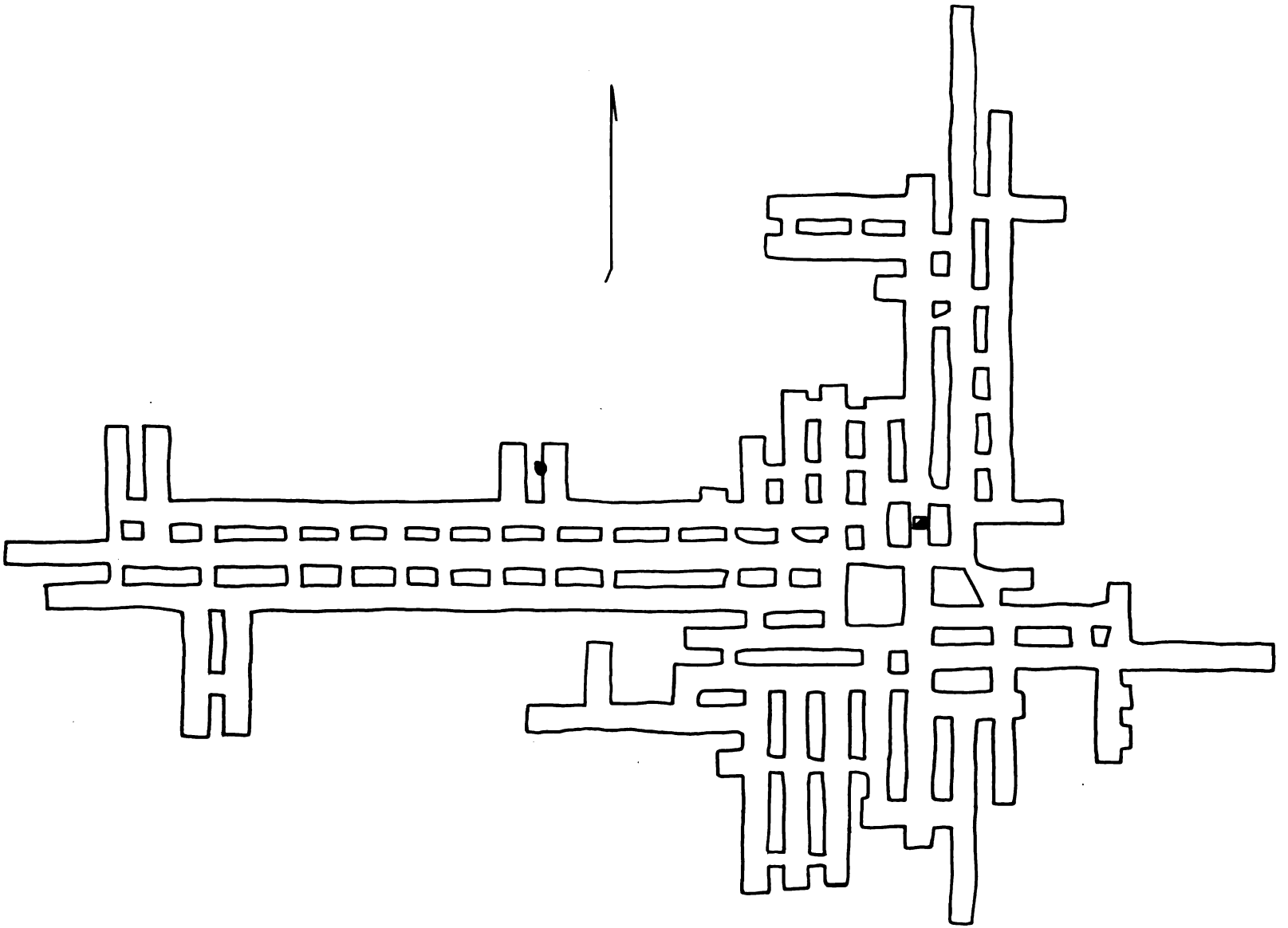

Figure 2.— Mine workings.

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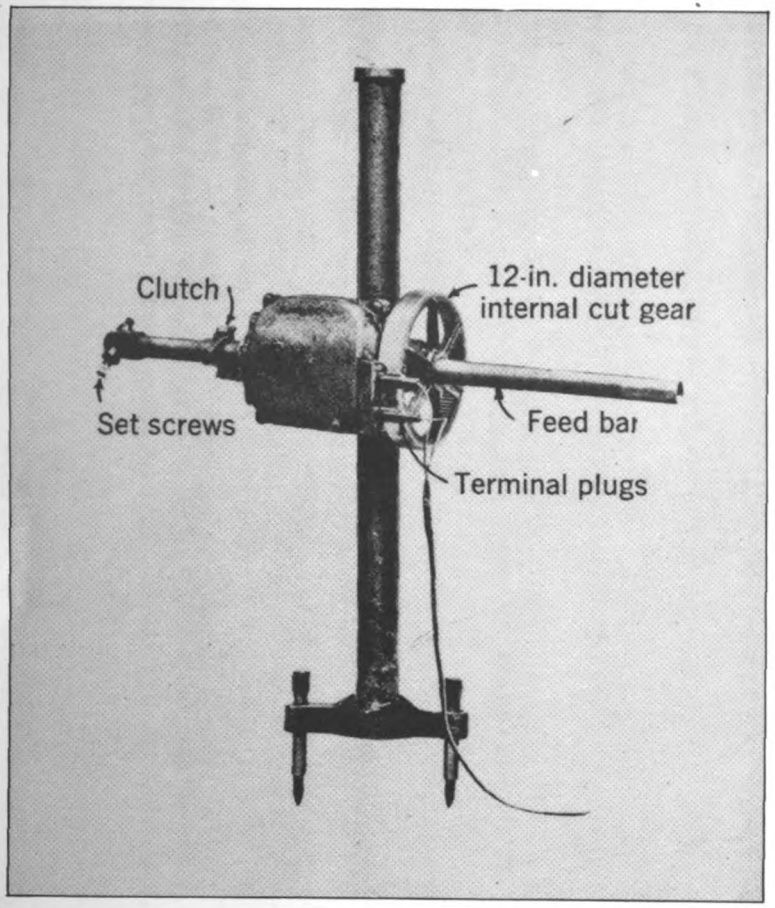

Figure 3.—Drill machine.

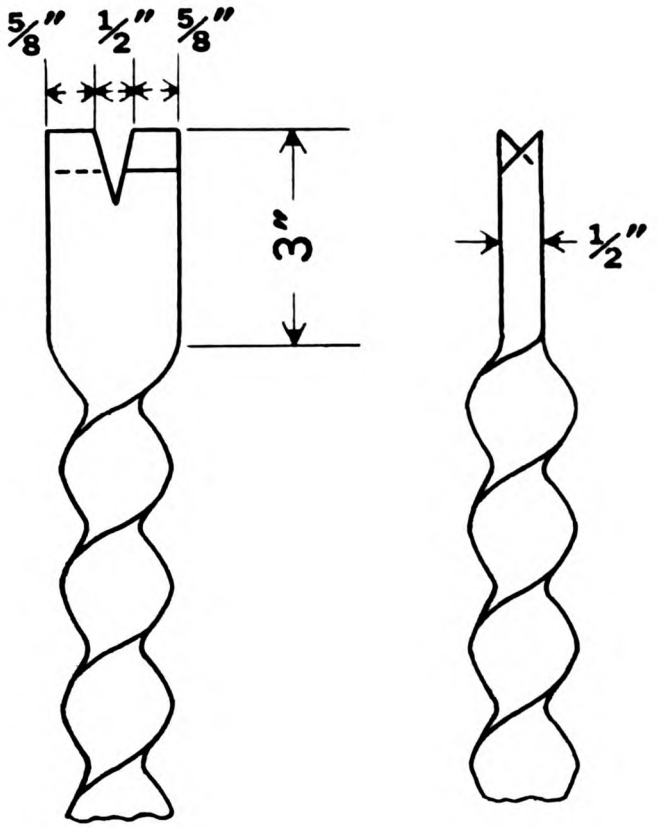

Figure 4.—Drill bit.

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and 5 feet in length, and has 10 threads per inch. A 5-inch-diameter chuck containing two set screws for holding the drill steel is mounted on the forward end of the feed bar. A split bronze feed nut with a friction clutch attached is used to regulate the forward movement of the feed bar. When the drill bit strikes hard material, such as anhydrite or dolomite, the friction clutch can be released. This instantly stops the forward movement of the feed bar but does not stop its rotation. This procedure is also used to remove the drill cuttings from the hole. Figure 3 is a sketch of the drill machine.

The drill is mounted on a heavy saddle clamp that is attached to a 3 1/2-inch-diameter steel column 52 inches long. Two adjusting screws 2 inches in diameter by 12 inches in length on the lower end of the column permit the column to be set firmly in place.

A cable reel 12 inches in diameter by 16 inches in length and containing approximately 150 feet of duplex rubber-insulated cable carries the direct current from the end of the permanent power line to the working face. Plug terminals on the end of the cable are used as switches to control the operation of the motor.

Twisted drill steel 1 1/2 inches in diameter, 9 feet in length, and having 9 turns per foot is used with a half-diamond-point bit. (See fig 4.) The cutting edges of the bit are tipped with "Stellite" and then sharpened on an emery wheel. The use of this metal materially increased the life of the cutting edge. Without Stellite, the bit became too dull for further use after drilling one hole. Now, as many as six holes can be drilled with one tip. Each driller is supplied with a small, hand, emery wheel in order that he may resharpen his own steel. This emery wheel is mounted on a 2-inch by 4-inch by 6-foot post that can be wedged easily into an upright position between the floor and roof near the working face.

The driller, working alone, erects the drill column about 4 feet behind the face. The drill machine is lifted onto the saddle clamp with the assistance of one of the loaders working nearby. The drill steel is then inserted in the hollow feed bar and the machine turned into position to drill the top hole. After the top hole has been drilled, the saddle clamp is loosened on the column, and the machine is lowered into position for the bottom hole. After this pair of holes has been drilled, the machine is removed from the column and the latter moved into a new position for the next pair of holes and the drilling cycle is repeated.

The top holes are collared 15 inches below the roof and inclined upward at an angle of 3°. The bottom holes are collared 12 inches above the floor and inclined downward at an angle of 5°. The holes, 1 3/4 inches in diameter, are generally drilled to a depth of 8 1/2 feet. About 5 1/2 minutes are required to drill a hole to this depth, the actual drilling speed being 24 inches per minute. Power consumption is at the rate of 0.018 kw.-hr. per

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foot. The driller will usually drill 12 to 14 holes in each face. When this round of holes has been completed, the rest of the shift is spent in preparing the explosives, stemming, and loading the holes. Figure 5 shows a typical drill round.

The drillers are paid on a contract basis, the rate being $0.22-1/2 per ton. They are required to supply their own explosives, these being obtained from the company.

BLASTING

A low-density special ammonia dynamite, size 1 1/8 by 8 inches, having an approximate strength of 20 percent, is used, together with No. 6 caps and triple-tape safety fuse. The fuse with the cap attached is laced diagonally through the stick of dynamite, and the cap is then inserted in the center of the stick. The stick containing the detonator is always placed last in the hole. Stemming shells 1 1/8 by 17 inches are rolled from newspaper and filled at the face with drill cuttings.

Six sticks of dynamite together with three stemming cartridges are placed in each top hole, while nine sticks of dynamite and three stemming cartridges are placed in the bottom holes. The fuses are trimmed to produce the order of firing as indicated by the numbers on figure 5.

The tamping bar is made of hardwood and measures 1 1/4 inches in diameter by 9 feet in length. A round of 14 holes will produce approximately 60 tons of gypsum or 1/2 ton per foot of drill hole. This is the equivalent of 0.71 pound of explosive per ton of gypsum broken. Secondary blasting seldom is required. The holes are loaded and fired at the end of the shift by each driller, unassisted. Adjoining drillers contact one another before they re-enter their respective rooms to light their holes, and meet again after leaving the face.

LOADING

All loading is done by hand, seven loaders being required to maintain the present tonnage. The loaders work alone, loading the gypsum into steel cars of 36-cubic-feet capacity. The gypsum usually is broken into one-man-size pieces and under, so that little blockholing or sledging is necessary. On an average, half of the pile of broken gypsum will be lumps ranging from 4 to 12 inches in diameter and the other half will be small enough to require shoveling. Each man will load an average of 25 tons of gypsum per shift. They are paid on a tonnage basis, the rate of pay being $0.17-1/2 per ton. All the necessary tools are furnished the loaders by the company.

TRANSPORTATION

The working places are all close together and the haulage distance relatively short, so that one electric locomotive can take care of the entire output. The locomotive is a 4 1/2-ton storage-battery type having 52 cells

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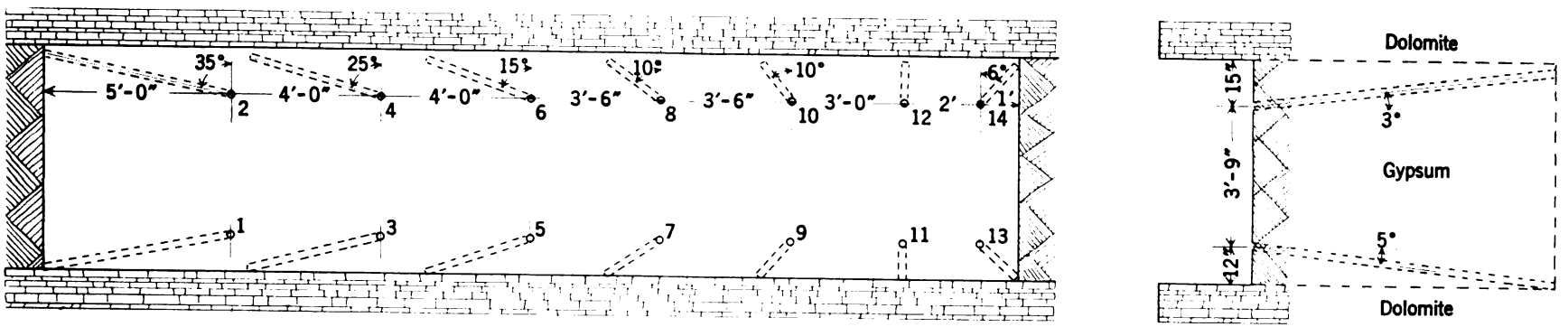

Figure 5.—Drill round.

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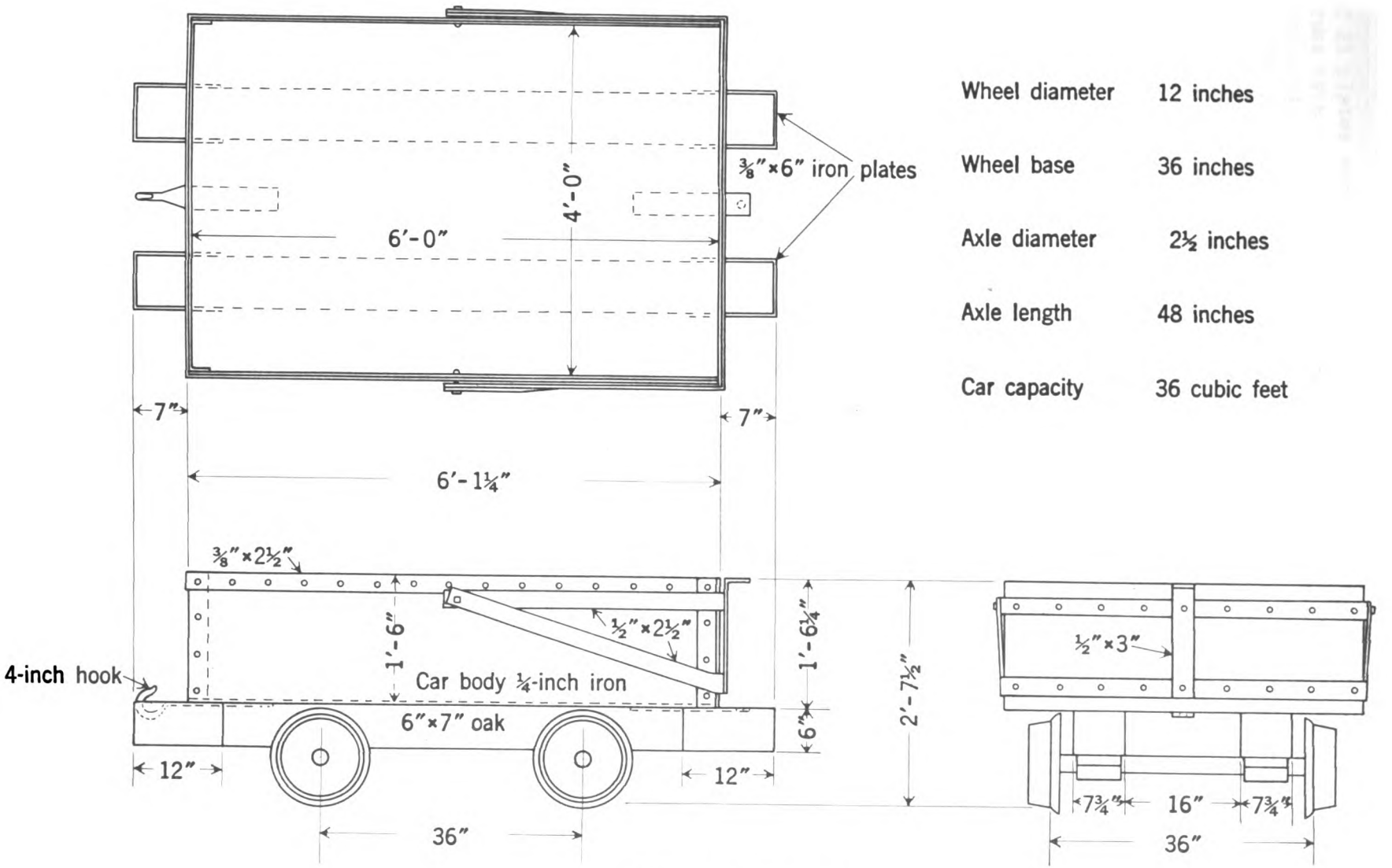

Figure 6.—Mine car.

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of 21 plates each and a drawbar pull of 500 pounds. It is of the outside-frame type of construction and measures 8 feet 8 inches long, 4 feet 2 inches wide, and 3 feet 9 inches high. Wheels are 20 inches in diameter and the wheel base is 30 inches. The locomotive is powered by a single 5 1/2-horsepower motor having a chain drive to both axles. The life of the batteries is about 5 years.

The charging station is near the shaft bottom. The batteries on the locomotive are connected to the AC-DC set at the end of the day shift and are charged for 11 hours. The charging set consists of a 7 1/2-horsepower, 440-volt, 60-cycle, 3-phase motor direct-connected to a 55-101-volt, 5.5-17-ampere generator, the unit traveling at a speed of 1,750 r.p.m.

Trains consist of five cars. The loaded cars are pushed by the loaders from the rooms to the entry, where they are coupled by the brakeman and then pulled to the shaft bottom by the locomotive. The motorman and brakeman then cage the cars, make up a train of five empties, and return inside. The haulage distance (1,000 feet) is such that too much time elapses while the locomotive makes a round trip to the shaft bottom. As a result, the loaders have to wait on empty cars.

The mine cars are of all-steel construction and have a capacity of 36 cubic feet. Their tare weight is 2,000 pounds, and they will carry an average net load of 5,000 pounds of gypsum. They are equipped with 2 1/2-inch-diameter axles and roller bearings. Twenty cars are in daily use. Figure 6 shows the mine cars.

Tracks are 36-inch gage. Thirty-pound rails are used throughout, being placed on untreated ties measuring 4 by 5 inches by 4 feet 6 inches, spaced 36 inches apart. The track requires considerable ballast. No. 2 1/2 frogs are used on all turnouts.

TIMBERING

Single posts are used to support the roof. They are placed in two rows, parallel with and 3 feet from each rail, to within 10 feet of the face. They are set on 10-foot centers in each row, the posts of one row being staggered with those in the row opposite. Hardwood wedges are used to fasten the posts in position. The timber used is cut locally and costs $0.06 per linear foot delivered. They measure 7 inches in diameter on the small end and are from 5 to 6 feet in length. Oak, maple, elm, birch, and beech are used.

The original posts placed in the mine are still in good condition, so that their exact life is as yet unknown. The amount of timber used during 1936 amounted to 0.37 linear foot per ton of gypsum mined.

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PUMPING

The mine workings produce a relatively small amount of water, requiring only one gathering pump. This is a double-acting plunger-type pump having a 6-inch-diameter piston and a 6-inch stroke. Its capacity, at a speed of 36 strokes per minute, is 50 gallons per minute. The cylinder has a renewable brass lining whose life is approximately 4 years. This pump is driven through a 5-inch by 6-foot rubber belt by a 3-horsepower, 440-volt, 4.5-ampere, 60-cycle, 3-phase motor traveling at a speed of 1,135 r.p.m. The discharge from this pump runs into the large sump near the shaft bottom.

The shaft or main sump has a capacity of about 35,000 gallons. A single-stage centrifugal pump operating against a head of 115 feet sends this water to the surface. This pump has a 3-inch bottom suction and discharge and its capacity is 300 gallons per minute. A plain, 4-inch-diameter, cast-iron, flanged pipe is used on the discharge. The pump is direct-connected to a 15-horsepower, 440-volt, 18.6-ampere, 60-cycle, 3-phase motor traveling at 1,760 r.p.m. It operates only about 4 hours daily.

A large amount of water was encountered in sinking the shaft. The source was confined to the upper 30 feet of strata. As the water proved to be suitable for drinking and plant use, a vertical pocket was made in the concrete lining to collect it. This pocket measures 3 feet by 4 feet by 20 feet in height and is placed in the wall of the manway. (See fig. 6.) A 4-inch centrifugal pump is in the manway opposite the bottom of the pocket and sends this water to a small concrete reservoir on the surface. This pump has a 4-inch bottom suction and discharge and a capacity of 300 gallons per minute. It is direct-connected to a 5-horsepower, 440-volt, 60-cycle, 3-phase motor traveling at 1,740 r.p.m. The volume of water is such that this pump operates 24 hours daily for approximately 8 months, and 16 hours daily the remaining 4 months.

Approximately 105,000,000 gallons of water are handled during an average year. For 1936 this amounted to 4,600 gallons per ton of gypsum mined.

SHAFT CAGE

The shaft of the Victor mine is vertical, measuring 14 feet 4 inches by 15 feet 5 inches and 110 feet in depth. It contains four compartments, two for hoisting and one each for ventilation and manway. The shaft is lined with concrete to a point 31 feet below the collar. Figure 7 is a cross-section of the concrete-lined portion of the shaft. The 6- by 10-inch buntons are set in the concrete itself, while below the concrete they are set in notches cut in the walls. The guides are made of 6- by 8-inch pine, butt joints being used. They are fastened to the buntons by two 7/8- by 9-inch lag screws. The end of the center bunton between the two hoisting compartments is supported on a metal bracket fastened to a 6-inch-square post that runs from the bottom to the top of the shaft. This is the only vertical member used.

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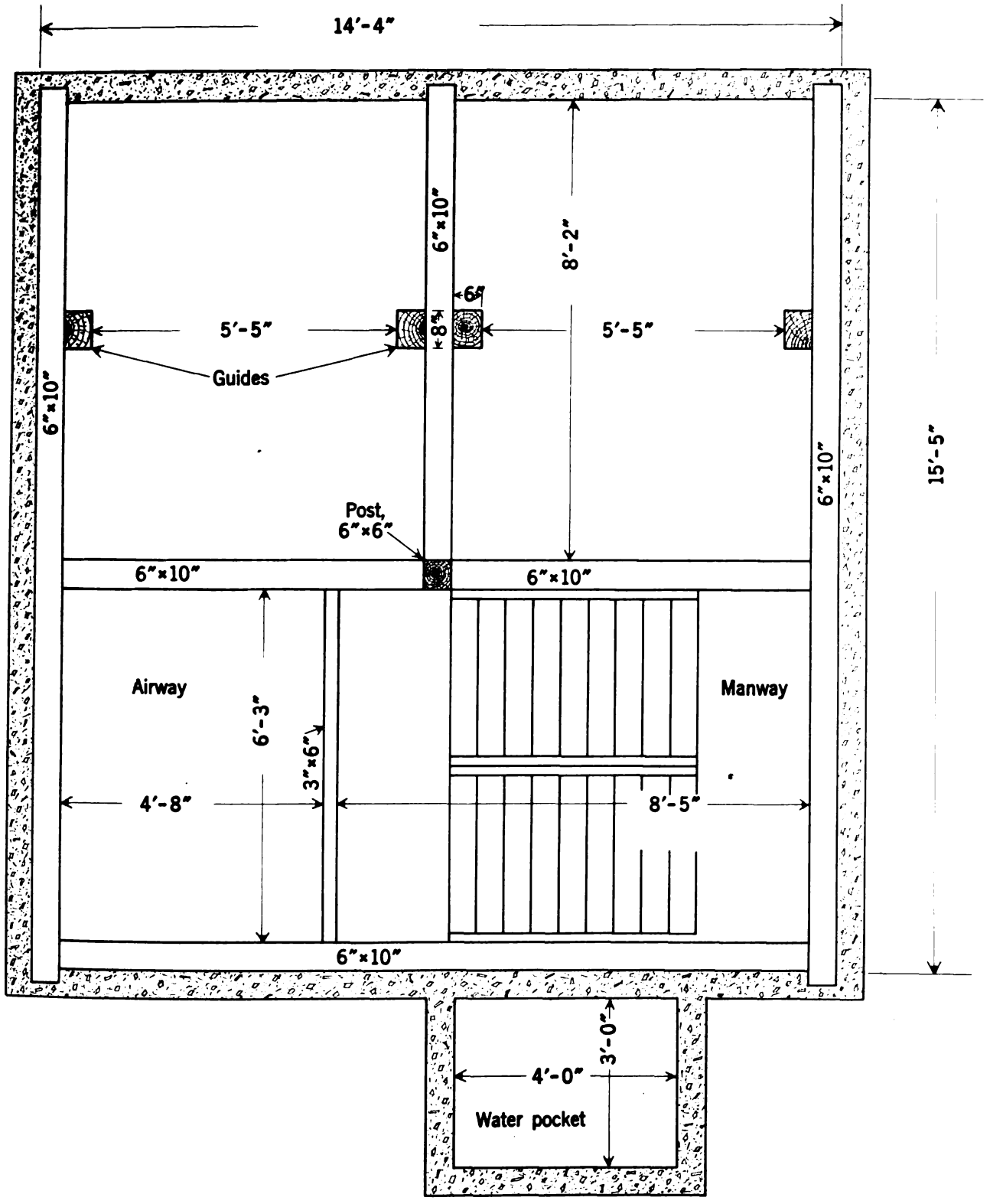

Figure 7.—Cross section of shaft.

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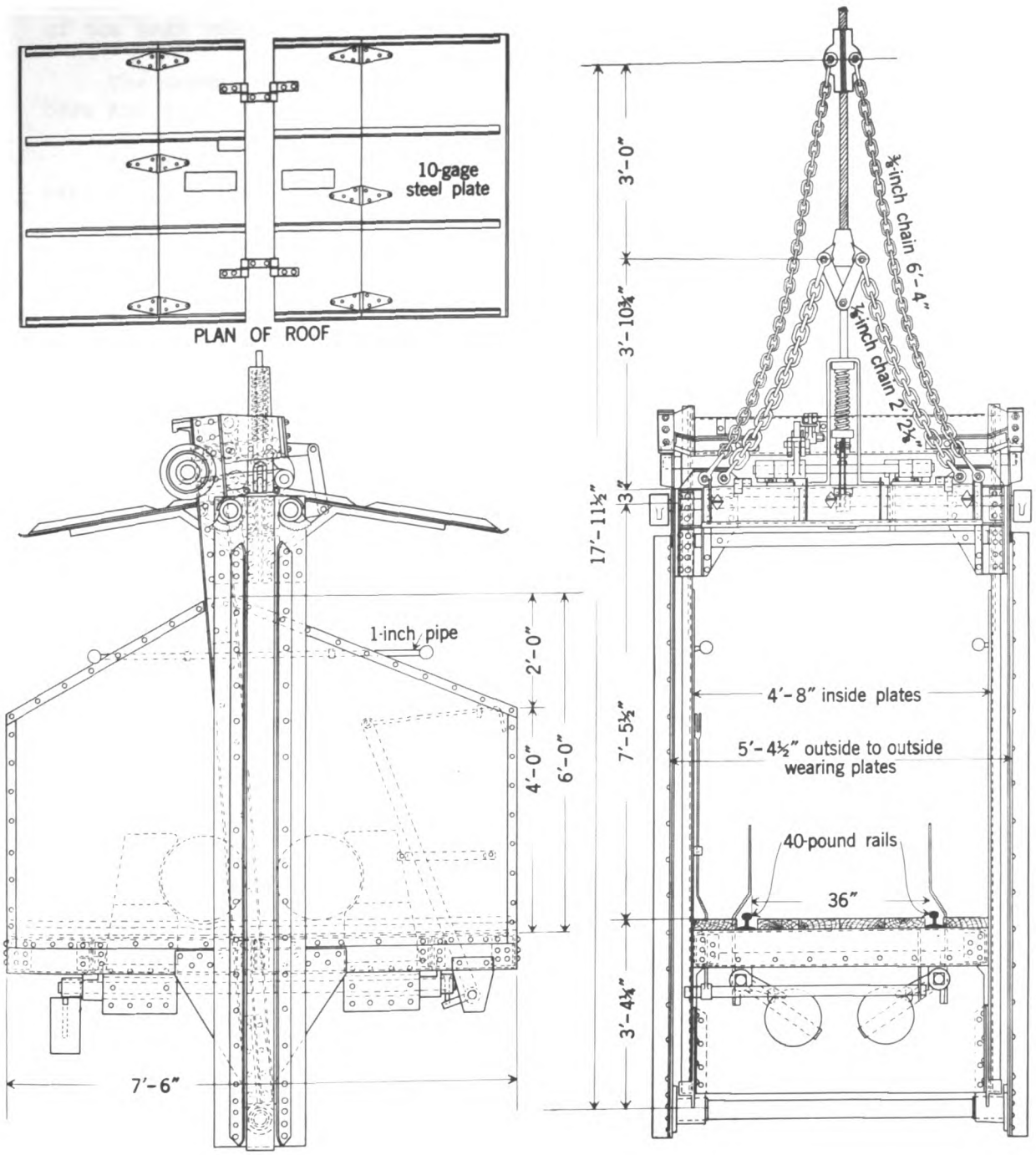

Figure 8.—Self-dumping cage.

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The hoisting compartments measure 6 feet 5 inches by 8 feet 2 inches inside the timbers and 5 feet 5 inches between the guide rails. The floor of the cage measures 4 feet 8 inches by 7 feet 6 inches.

The manway measures 6 feet 3 inches by 8 feet 5 inches inside the timbers and is provided with a wooden stairway 30 inches wide.

The airway measures 6 feet 3 inches by 4 feet 8 inches inside the timbers and is lined with 1-inch tongue-and-groove pine lumber.

The headframe is steel, approximately 60 feet in height, and is entirely enclosed with corrugated steel.

The mine cars are hoisted to the surface on automatic self-dumping cages of the double-frame type. The outer frame runs in the shaft guides in the regular manner. An inner frame containing a platform on which the mine car rides is pivoted to the outer frame near the bottom. The top end of the inner frame is swung outward at the dumping point by means of two rollers engaging in curved guides. These guides also support the car and the inner frame at the proper dumping angle. The outer frame, meanwhile, runs up on the main guides.

The cage is provided with two center-hinged bonnets, 4 feet 4 1/4 inches by 3 feet 5 3/4 inches, made of 10-gage steel. Safety catches of the toothed-cam type are used. The cable is attached to a 7/8-inch-diameter by 2 feet 2 1/8 inch carrying chain, while an auxiliary or safety chain measuring 3/8-inch diameter by 6 feet 4 inches is fastened to a clamp on the cable above the cable socket. The mine car is held on the cage by means of horns in front of the wheels and is operated by weights and levers when the cage leaves the landing. The cage weighs approximately 4,000 pounds. Figure 8 is a sketch of the cage.

VENTILATION

The airway of the four-compartment shaft serves as the downcast. A 36-inch-diameter multivane fan having a side inlet and a bottom discharge and capable of delivering 25,000 cubic feet of air per minute is at the foot of the airway. The fan is driven by a 5-horsepower, 440-volt, 60-cycle, 3-phase motor traveling at a speed of 1,740 r.p.m. The hoisting compartments serve as the upcast.

Permanent brattices in the mine are made by erecting two dry walls of waste stone about 4 feet apart and filling the space between them with waste material. Temporary brattices are made by hanging brattice cloth where necessary. As all the blasting is performed at the end of the shift, an excellent supply of fresh air is provided at all working faces.

An auxilary air and escape shaft is planned, and work will be started on this in the near future.

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HOISTING

A single-drum, slow-speed, semiautomatic, electric, geared hoist is used. This unit is about 10 feet from the west side of the shaft in a low wing of the crusher building. Balanced hoisting is employed, a single cylindrical drum measuring 50 inches in diameter by 30 inches long and turning at a speed of 12 r.p.m. being used. It is driven by a 50-horsepower, 440-volt, 75-ampere, 60-cycle, 3-phase motor traveling at a speed of 720 r.p.m. The rope speed is 155 feet per minute, approximately 62 seconds being required to raise a loaded car from the shaft bottom to the dumping position.

The cable is 1 inch in diameter, regular lay, 6 by 19, hemp center, plow steel. Two separate lengths of cable, one for each cage, measure 250 and 260 feet, respectively. Twelve wraps are on the drum when the cage is at the dumping point, while 1 1/2 wraps remain when the cage is at the bottom. The life of the cable is approximately 2 years.

The hoist is operated through remote control by the crusherman from his position beside the scale on the second floor of the crusher building. He sets the hoist in motion upon receiving the proper signal from the cager below, and automatic controls bring it to rest when the cage reaches the dumping point. The hoist signal is a simple electric bell operated from the 440-volt power line.

CRUSHING PLANT

Figure 9 is a sketch showing the crushing-plant layout. Figure 10 is the flow sheet covering the following operations.

WEIGHING

The mine cars are dumped upon a metal chute and the gypsum falls into a single suspended weigh-hopper (2)1/ placed at a point midway between and opposite the two hoist compartments. The gypsum is weighed by hand on a single-beam scale having a maximum capacity of 6,000 pounds. The operator stands before this scale and determines the weight of each carload and notes the loader's number on the car. The cars range in weight from 4,500 to 5,200 pounds net. This man, from his position in front of the scale, operates, through remote control, the crusher feeder, the crusher, elevator, and revolving screen.

The gypsum is discharged from the weigh hopper into a steel bin (3), which stands on the ground level below. This bin is 7 feet square and is directly above a pan conveyor, upon which the gypsum is allowed to feed by gravity. The capacity of this bin is 250 cubic feet, or about 12 tons of gypsum.

1/ Numbers refer to flow sheet, fig. 10.

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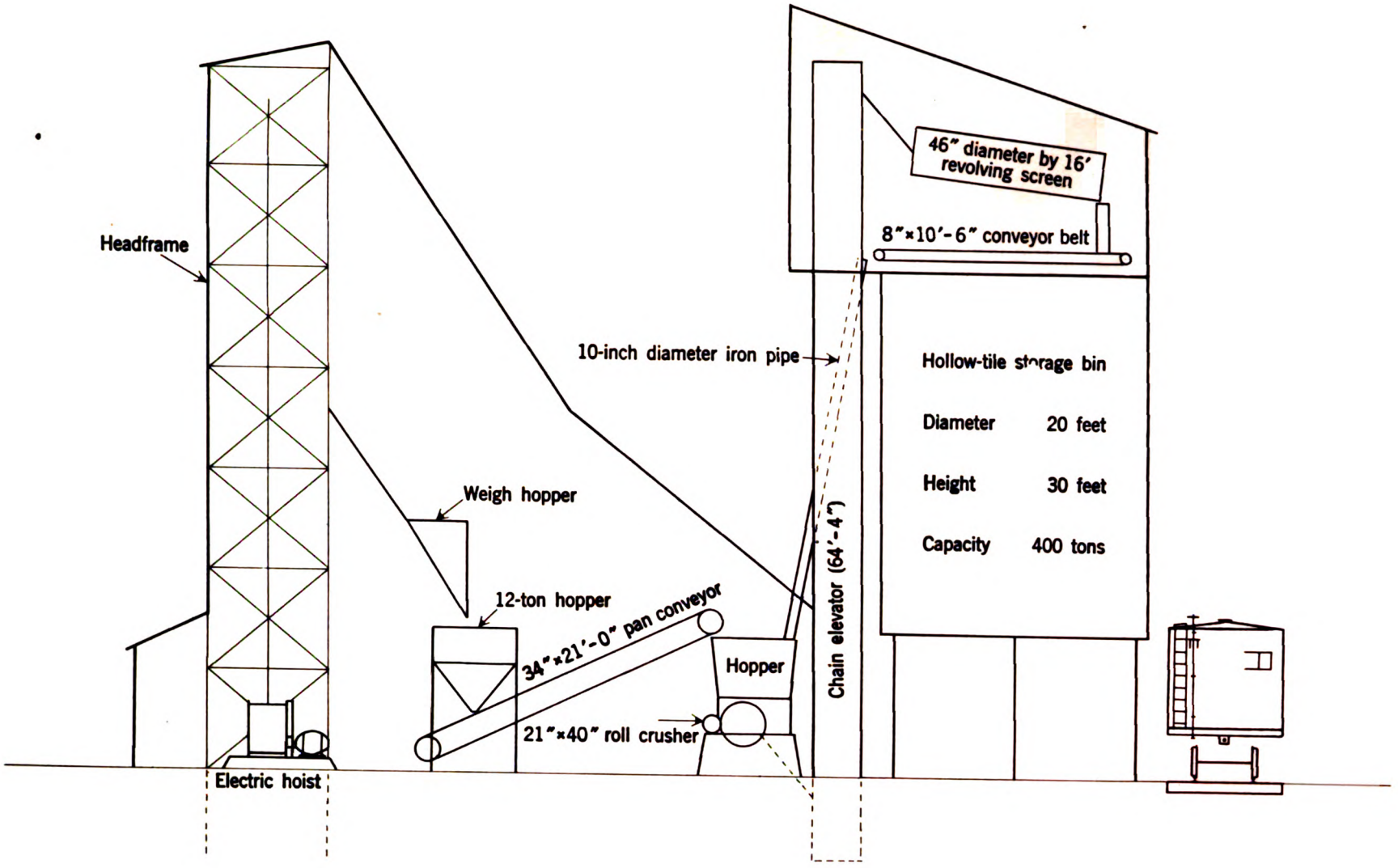

Figure 9.—Side elevation, crushing plant.

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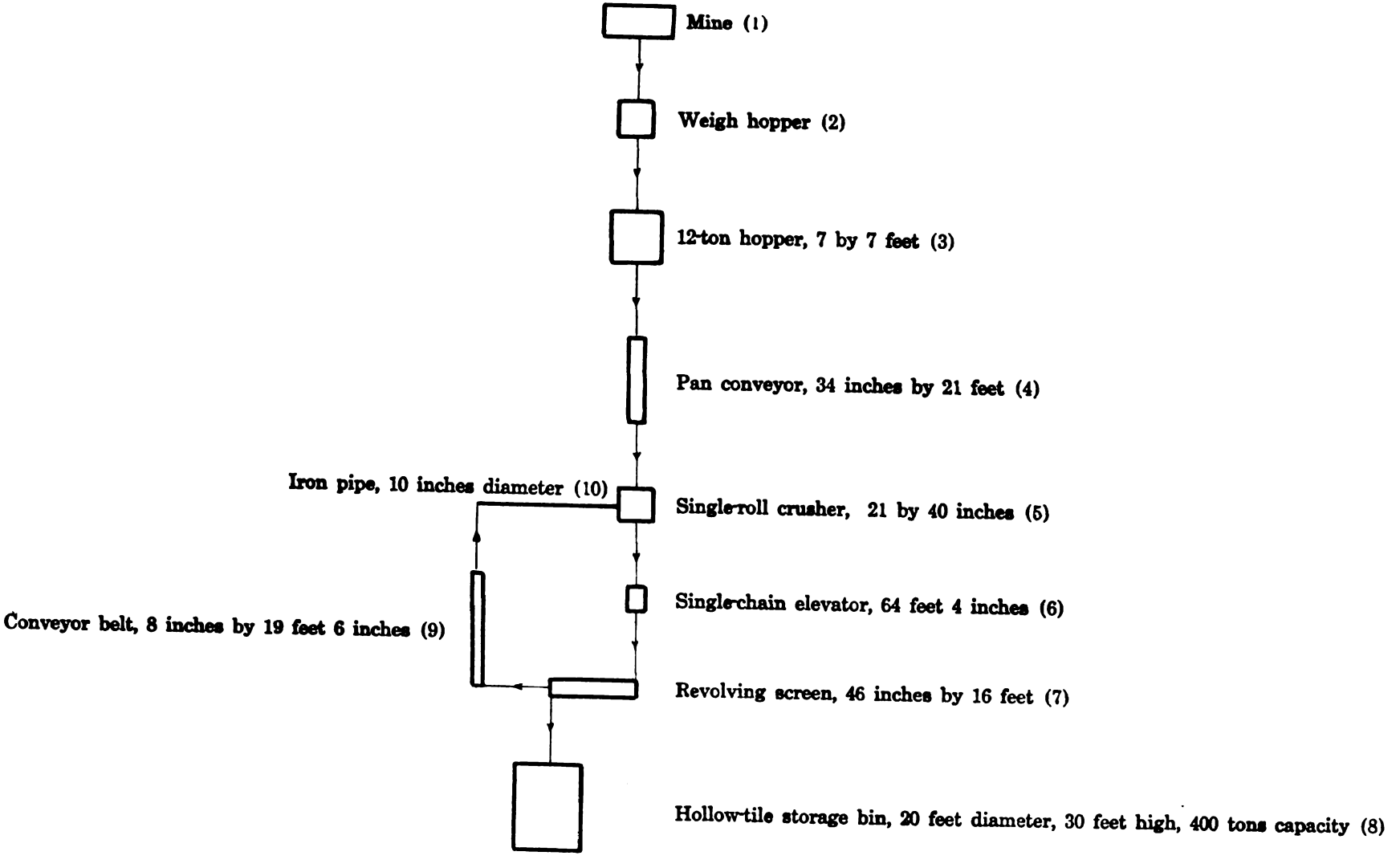
Mine (1)
Weigh hopper (2)
12-ton hopper, 7 by 7 feet (3)
Pan conveyor, 34 inches by 21 feet (4)
Iron pipe, 10 inches diameter (10)
Single-roll crusher, 21 by 40 inches (5)
Single-chain elevator, 64 feet 4 inches (6)
Conveyor belt, 8 inches by 19 feet 6 inches (9)
Revolving screen, 46 inches by 16 feet (7)
Hollow-tile storage bin, 20 feet diameter, 30 feet high, 400 tons capacity (8)

Figure 10.—Flow sheet.

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CONVEYING

The pan conveyor (4) is 34 inches wide on 21-foot centers and is set at an angle of 20° above horizontal. The pans measure 14 inches by 34 inches and travel on 5-inch-diameter, single-flange, cast-steel wheels set on a 14-inch pitch. The rated capacity of the conveyor traveling at a speed of 6 feet per minute is 40 tons per hour. It is driven through a quadruple reduction drive by a 5-horsepower, 440-volt, 6.6-ampere, 60-cycle, 3-phase motor traveling at 1,150 r.p.m. The first reduction is a 5-inch by 9-foot 2-inch rubber transmission belt; the second reduction is a sprocket and chain; while the third and fourth reductions have cut spur gears. The gypsum is discharged from this conveyor into a hopper 4 feet wide by 6 feet long by 5 feet deep placed directly above the crusher.

CRUSHING

All crushing is done by a single-roll machine, the roll being 21 inches in diameter by 40 inches in length mounted on a 5-inch-diameter shaft turning at 50 r.p.m. The size of the crusher opening is 1 1/4 inches. The rated capacity of the crusher traveling at a peripheral speed of 285 feet per minute is 60 tons per hour. A 75-horsepower, 440-volt, 98-ampere, 60-cycle, 3-phase motor traveling at 695 r.p.m. drives the crusher through a 16 inch by 12 foot 6 inch rubber transmission belt.

ELEVATING

The crushed gypsum falls directly into the well of a vertical, steel-enclosed elevator (6) that lifts it to a revolving screen. The elevator is of the single-chain, plain-sprocket type and measures 64 feet 4 inches on centers. Buckets 7 by 7 1/2 by 14 inches are spaced 16 inches apart. Head and tail sprockets are of the toothless-rim or traction-wheel type, 20 inches in diameter. The rated capacity of this elevator traveling at a speed of 240 feet per minute is 95 tons per hour. It is driven through a double-spur gear-reduction drive by means of a 20-horsepower, 440-volt, 25-ampere, 60-cycle, 3-phase motor traveling at 1,170 r.p.m.

SCREENING

The elevator discharges into a cylindrical revolving screen (7) 46 inches in diameter by 16 feet in length set at an angle of 9° below the horizontal. It turns at a speed of 15 r.p.m., and the peripheral speed is 180 feet per minute. The screening surface is made up of three cylindrical sections of punched plate 48 inches in length and having 1 1/4-inch-diameter openings. The life of these screen plates is unknown, as the original plates still remain in use after 7 years. The screen is driven by a roller chain from the first reduction shaft of the elevator drive.

The revolving screen is on top of the circular storage bin (8), so that the undersize material falls directly into it. The oversize produce falls upon a short steel chute and then onto an 8-inch by 19-foot 6-inch horizontal

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conveyor belt (9) that discharges into a 10-inch-diameter iron pipe (10), where it is returned to the roll crusher (5) on the first floor. The head and tail pulleys of this conveyor are 14 inches in diameter with an 18-inch face, and turn at 70 r.p.m., giving the belt a speed of 240 feet per minute. It is driven through a roller chain from the first reduction shaft of the elevator drive.

STORAGE BIN

The crushed-gypsum storage bin (8) is constructed of hollow, vitrified, salt-glazed tile 6 inches thick by 10 by 12 inches, and measures 20 feet in diameter by 30 feet in height. The bin itself rests upon a concrete base or platform set 12 feet above the ground elevation, affording ample headroom beneath for the discharge chute and feeders. The capacity of the bin is 945 cubic feet, or approximately 400 tons of crushed gypsum.

MISCELLANEOUS

A motor-generator set that supplies direct current to the drilling machines is in the surface blacksmith shop. The set consists of a 35-horsepower, 440-volt, 42.5-ampere, 60-cycle, 3-phase motor traveling at 1,150 r.p.m., direct-connected to a 250-volt, 100-ampere, 25-kw. generator. This unit operates 7 1/2 hours daily.

POWER

The electric power for both mine and crushing plant is purchased from the Rochester Gas & Electric Corporation on a sliding-scale basis, the rate averaging 1 7/8 cents per kw.-hr. The daily rated kw.-hr. required is 1,636, or the equivalent of 1.9 kw.-hr. per ton of gypsum produced.

PERCENT EXTRACTION

The initial mining operation yields an approximate recovery of 75 percent. The remaining 25 percent will be recovered later by removing the pillars when retreating after the property limits have been reached.

The crushing plant delivers the same tonnage it receives from the mine, there being no loss due to fines.

EMPLOYEE PAY SYSTEM

The mine is operated on a single 8-hour-day shift. The loaders and drillers are paid on a tonnage basis. The remaining men are all paid on an hourly basis. The base rates of pay for an 8-hour day are as follows:

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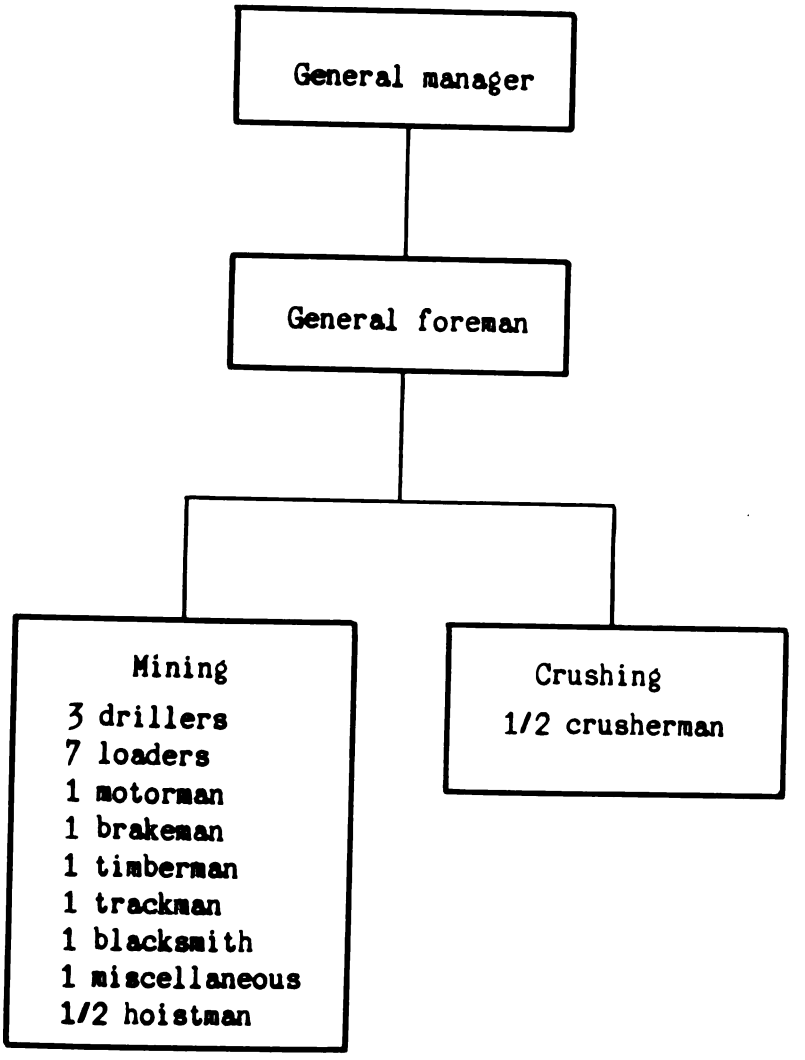

Figure 11.- Organization chart.

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Labor classification	Number of men	Rate of pay
Drillers	7	$0.22½ per ton
Loaders	7	.17½ per ton
Motormen	1	.40 per hour
Brakeman	1	.40 per hour
Timberman	1	.40 per hour
Trackman	1	.40 per hour
Miscellaneous	1	.40 per hour
Hoist-crusher man	1	.40 per hour
Blacksmith	1	.50 per hour

Most of the employees live nearby, and the labor turnover is very small. The mine averages in a normal year 30,000 man-hours of labor and operates approximately 200 eight-hour days per year.

SAFETY METHODS AND FIRST-AID ORGANIZATION AND TRAINING

First-aid materials are kept on hand to treat injuries. In case of a serious accident, the patient is rushed to a hospital in one of the neighboring towns.

Explosives are handled only by experienced men. The timbering is always kept up to within 10 feet of the working face. Close supervision is maintained by the foreman, as the working places are all close together.

The surface plant is of modern steel construction, well lighted, and kept clean and orderly at all times. Minor accidents are few and major accidents rare.

FORM OF ADMINISTRATION ORGANIZATION

Figure 11 is an organization chart of the mine and crushing plant. The general foreman has full authority over both mine and crushing plant, and he is responsible for properly selecting his own personnel.

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I. SUMMARY OF COSTS

NAME OF MINE - Victor Plaster, Inc.
PERIOD COVERED - 1936
TOTAL TONS GYPSUM MINED DURING PERIOD - 22,460

OPERATING COSTS PER TON GYPSUM MINED

Classification	Labor	Super-vision	Air drills, steel	Power cost	Explosives cost	Other supplies	Total
Mining:							
Drilling.....	$0.894	---	$0.0033	$0.0176	---	$0.0048	$0.1151
Blasting.....	.0286	---	---	---	$0.1101	---	.1387
Loading.....	.1750	---	---	---	---	---	.1750
Transportation	.1001	---	---	.0101	---	.0192	.1294
Timbering.....	.0291	---	---	---	---	.0224	.0515
Pumping.....	.0491	---	---	.0468	---	.0082	.1041
Hoisting.....	.0164	---	---	.0095	---	.0118	.0377
Miscellaneous.	.0347	$0.0533	---	.0090	---	.0091	.1061
Total mining....	.5224	.0533	.0033	.0930	.1101	.0755	.8576
Crushing plant:							
Crushing.....	.0079	---	---	$0.0388	---	$0.0001	$0.0468
Elevating.....	.0069	---	---	.0082	---	.0039	.0190
Screening.....	.0041	---	---	.0038	---	.0009	.0088
Conveying.....	.0074	---	---	.0045	---	.0057	.0176
Miscellaneous.	.0137	$0.0089	---	.0011	---	.0052	.0289
Total crushing..	.0400	.0089	---	.0564	---	.0158	.1211
Grand total.....	.5624	.0622	.0033	.1494	.1101	.0913	.9787

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II. SUMMARY OF COSTS IN UNITS OF LABOR, POWER, AND SUPPLIES

	Mining	Crushing	Other	Total
Labor (man-hours per ton):				
Drilling	0.120	---	---	0.120
Blasting	.040	---	---	.040
Loading	.373	---	---	.373
Haulage	.160	---	---	.160
Timbering	.053	---	---	.053
Hoisting	.027	---	---	.027
Miscellaneous	.106	0.027	0.053	.186
Total labor	.879	.027	.053	.959
Average tons per man-shift	9.660	300.000	150.000	8.820
Labor, percent of total cost				63.810
Power supplies:				
Explosives (pounds per ton)	.710	---	---	.710
Timber (linear feet per ton)	.370	---	---	.370
Total power (kw.-hr. per ton):				
1. Drills	.700	---	---	.700
2. Locomotives	.410	---	---	.410
3. Pumping	2.466	---	---	2.466
4. Hoisting	.375	---	---	.375
5. Ventilation	.370	---	---	.370
6. Crushing	---	1.500	---	1.500
7. Screening	---	---	.100	.100
8. Elevating	---	---	.400	.400
9. Conveying	---	---	.150	.150
Other supplies, in percent of total supplies and power	---	---	---	20.110
Supplies and power, percent of total cost	---	---	---	36.190

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III. DETAILED SUMMARY MINE COSTS DIRECT OPERATION

Classification	Amount	Cost per ton	Total unit cost per ton
Loading	$3,930.50	$0.1750	$0.1750
Drilling:			
Operating labor	1,933.38	.0860	—
Power	395.20	.0176	—
Operating supplies	75.63	.0033	—
Repair labor	76.78	.0034	—
Repair supplies	107.30	.0048	—
Total drilling	2,588.29	—	.1151
Blasting:			
Labor	644.47	.0286	—
Explosives	2,475.65	.1101	—
Other supplies			
Total blasting	3,120.12	—	.1387
Haulage:			
Locomotive	1,573.60	.0698	—
Cars	476.57	.0212	—
Track	863.00	.0384	—
Total haulage	2,913.17	—	.1294
Timbering:			
Labor	652.80	.0291	—
Supplies	505.08	.0224	—
Total timbering	1,157.88	—	.0515
General charges	5,615.24	—	.2479
Grand total	19,225.20	—	.8576
Cost per ton, all material	6,288.80	—	.2819

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